

Terrestrial Hypotrichous Ciliates from Chindo Island, Korea

Mann Kyoon Shin and Won Kim*

(Department of Biology, University of Ulsan, Ulsan 680-749, Korea; *Department of Molecular Biology, Seoul National University, Seoul 151-742, Korea)

ABSTRACT

Five hypotrichs inhabiting the representative aquatic and terrestrial habitats of Chindo Island, *Strongylidium muscorum*, *Gonostomum affine*, *Histiculus cavicola*, *H. muscorum*, *Steinia quadrinucleata* are discovered from Chindo Island. Of these, two species, *Strongylidium muscorum* Kahl, 1932 and *Steinia quadrinucleata* Dragesco and Njiné, 1971 are newly recorded from Korea.

Key words: Hypotrichs fauna. Hypotrichida. redescription. Chindo Island. Korea

INTRODUCTION

The hypotrichs from Chindo Island have not been studied up to now. In the present study, five hypotrichs were identified. Of these, two species of hypotrichs are discovered for the first time from Korea. We present a collection data on hypotrichs from Chindo Island and redescribe the two hypotrichs new to Korea with illustrations.

The present study was based on the specimens collected in several localities of Chindo Island (between 125°37' -126°28' E and 34°08' -34°35' N) during the period of 23-25 July 1994. The collectings were performed at representative terrestrial habitats such as mosses, forests, grasslands and cultivated field. Laboratory cultures were maintained in a commercial mineral water provided with boiled wheat grains and shrimp meats for supplying fungal and bacterial nutrients of hypotrichs.

The shapes of the living specimens were based on the pictures captured by CCD camera. The

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infraciliature was observed by using the modified protargol method (Wilbert, 1975; Shin and Kim, 1993). The drawings of the impregnated specimens were made with the aid of a drawing tube. Biometrical analysis was performed using the methods described in Sokal and Rohlf (1981). We adopted the classification schemes established by Small and Lynn (1985) and Lynn and Corliss (1991).

RESULTS AND DISCUSSION

Phylum Ciliophora Doflein, 1901 有毛蟲門

Class Polyhymenophora Jankowski, 1967 多膜綱

Order Hypotrichida Stein, 1859 下毛目

Family Strongylidae Fauré-Fremiet, 1961 둘레선회하모과(신칭)

Genus *Strongylidium* Sterki, 1878 둘레선회하모충속(신칭)

1. *Strongylidium muscorum* Kahl, 1932 이끼둘레선회하모충(신칭) (Fig. 1)

Strongylidium muscorum Kahl, 1932, p. 553, fig. 17; Stiller, 1974, p. 11, fig. 6D; Foissner, 1984, p. 107, figs. 55a-f, table 26.

Material examined. 18 specimens, Ŭishin-myŏn, Kŭmgap-ri; 20 specimens, Chindo-ŭp, Kyodong-ri. Of these, 14 protargol impregnated specimens were analyzed biometrically and their data were summarized in Table 1.

Description. General morphology and behavior: Body soft and flexible, elongate or long sigmoidal in shape, flattened dorso-ventrally, ranging from 150-240 μm long and 30-70 μm wide; anterior end narrowed and slightly pointed; anterior part of left body margin oblique and slightly concave; posterior end tapered; dorsal surface convex. Crawling movement slow and its direction changing frequently.

Frontal and buccal fields: Four frontal cirri (FC) large and prominent, located at ventral surface of anteriormost part; one buccal cirrus (BC) located at anteriormost point of undulating membrane. Adoral zone of membranelles (AZM) of 46-68 μm long with 30-48 prominent adoral membranelles (AM), covering approximately 30% of body length. Buccal field large and deep, comprising of undulating membrane (UM) 34-48 μm long. Pharyngeal fibers (PF) at base of buccal field slanted to right posterior of body and 19-31 μm long.

Somatic infraciliature: No transverse cirri (TC) and caudal cirri (CC). Right and left rows of marginal cirri (RMC & LMC) extending almost to posterior end and nearly confluent posteriorly; RMC beginning at dorsal surface of anterior end near middle FC and bearing 38-54 cirri; LMC beginning at region beneath 3rd-5th AM and bearing 23-50 cirri; number of RMC more than LMC by ten. Dorsal surface bearing four dorsal kineties (DK); rightmost row of DK beginning at dorsal surface of buccal base; cilia on dorsal surface bristle-like, approximately 5 μm long, some of them more or less shortened. Middle ventral cirral (MVC) rows separated as left and right MVC (LMVC & RMVC); LMVC bearing 30-52 cirri, beginning at beneath FC and extended to posterior part of body; RMVC bearing 5-11 cirri and lined posterior end. Postoral ventral cirrus (poVC) bearing one cirrus, located beneath buccal field.

Nuclear organelles with 20-29 long oval macronuclei (Ma), 7-14 μm long and 2-5 μm wide,

Table 1. Biometrical characterization of *Strongylidium muscorum* (upper line) and *Steinia quadrinucleata* (lower line). All data were based on protargol impregnated specimens. The abbreviations in the table are the same as in the description except statistical terms (Max.: maximum; Min.: minimum; SD: standard deviation; SE: standard error; CV: coefficient of variation in %; n: population size).

CHARACTERS	Mean	Median	Max.	Min.	SD	SE	CV (%)	n
Body length	195.43	195	235	151	23.44	6.27	12.00	14
	179.43	176	203	159	14.66	5.54	8.17	7
Body width	47.64	45.5	67	25	11.42	3.05	23.97	14
	88.43	90	102	65	14.16	5.35	16.02	7
Body length/width	4.29	4.17	7.20	2.73	1.01	0.27	23.56	14
	2.06	1.99	2.45	1.86	0.21	0.08	10.33	7
AZM length	56.79	58	68	46	8.40	2.25	14.80	14
	76.14	74	87	68	6.41	2.42	8.42	7
Body length/AZM length	3.47	3.60	3.82	2.87	0.34	0.09	9.66	14
	2.36	2.34	2.51	2.22	0.10	0.04	4.41	7
UM length	40.64	41.5	48	34	5.17	1.38	12.72	14
	60.57	59	71	52	6.37	2.41	10.52	7
UM/AZM length	0.72	0.72	0.77	0.63	0.04	0.01	5.01	14
	0.79	0.80	0.82	0.76	0.02	0.01	2.30	7
Ma length	9.86	10	14	7	1.99	0.53	20.23	14
	14.00	14	17	11	2.16	0.82	15.43	7
Ma width	3.86	4	5	2	0.86	0.23	22.41	14
	11.86	12	16	10	2.19	0.83	18.50	7
Mi diameter	—	—	—	—	—	—	—	—
	3.86	4	4	3	0.38	0.14	9.80	7
Ma number	26.00	26.5	29	20	3.09	0.83	11.88	14
	3.83	4	4	3	0.41	0.17	10.65	6
Mi number	—	—	—	—	—	—	—	—
	5.00	6	6	3	1.55	0.63	30.98	6
DK number	4.00	4	4	4	0.00	0.00	0.00	13
	6.00	6	6	6	0.00	0.00	0.00	6
AM number	38.00	36.5	48	30	5.35	1.43	14.08	14
	38.00	39	42	32	4.04	1.53	10.64	7
BC number	1.00	1	1	1	0.00	0.00	0.00	14
	1.00	1	1	1	0.00	0.00	0.00	7
FC number	4.00	4	4	4	0.00	0.00	0.00	14
	3.00	3	3	3	0.00	0.00	0.00	7
FVC number	—	—	—	—	—	—	—	—
	4.00	4	4	4	0.00	0.00	0.00	7
LMVC number	42.18	44	52	30	7.08	2.14	16.79	11
	—	—	—	—	—	—	—	—
RMVC number	7.56	8	11	5	2.07	0.69	27.37	9
	—	—	—	—	—	—	—	—
poVC number	1.00	1	1	1	0.00	0.00	0.00	11
	3.00	3	3	3	0.00	0.00	0.00	7
VCnTC number	—	—	—	—	—	—	—	—
	2.00	2	2	2	0.00	0.00	0.00	7
TC number	—	—	—	—	—	—	—	—
	5.00	5	5	5	0.00	0.00	0.00	7
CC number	—	—	—	—	—	—	—	—
	3.00	3	3	3	0.00	0.00	0.00	5
LMC number	40.91	40	50	36	4.23	1.28	10.34	11
	16.29	16	18	15	1.11	0.42	6.83	7
RMC number	47.27	48	54	41	4.17	1.26	8.83	11
	16.86	16	19	16	1.21	0.46	7.21	7
PF length	23.33	22	31	19	4.63	1.89	19.86	6
	34.43	33	53	24	10.50	3.97	30.50	7

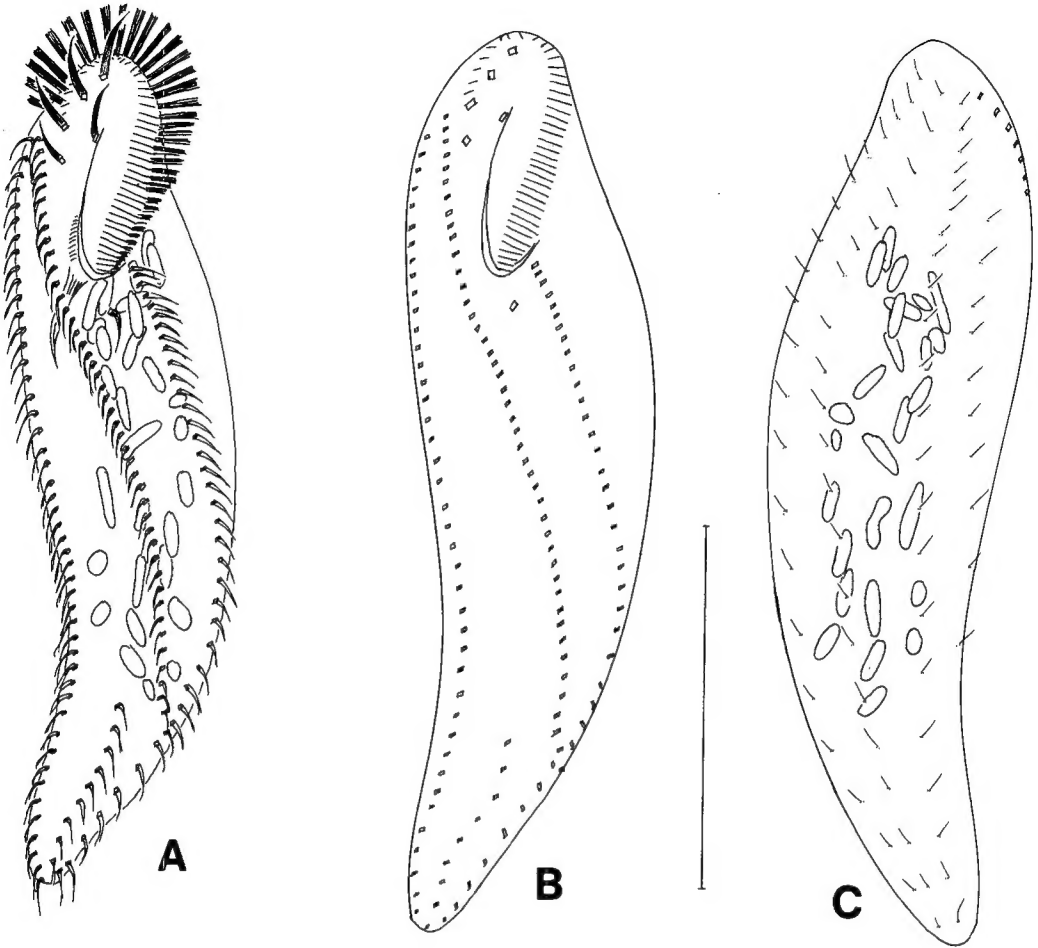


Fig. 1. *Strongylidium muscorum* Kahl, 1932: **A**, live specimen, ventral view. **B**, infraciliature after protargol impregnation, ventral view. **C**, infraciliature after protargol impregnation, dorsal view (Scale bar = 80 μ m).

scattered middle part of body. Contractile vacuole spherical, positioning near middle of left margin of body.

Habitat. Mosses or moss-covered soil.

Distribution. Germany, Hungary, Austria and Korea.

Remarks. This species has been known only in Europe. The morphological characters of this species in previous local populations are mostly similar to but slightly different from Korean population. Especially, body size, length of AZM, number of AM, both marginal cirri and middle ventral cirri are different between the two populations. The body size of Korean population is relatively larger than that of Austrian population. The Korean population has the average AZM length of 56.79 μ m (40.46 μ m in Austrian's), average AM number of 38.00 (44.92 in Austrian's), average RMC number of 47.27 (62.69 in Austrian's), average LMC number of 40.91 (58.31 in Austrian's), average RMVC number of 7.56 (10.69 in Austrian's) and average LMVC number of 42.18 (61.31 in Austrian's) (Kahl, 1932; Stiller, 1974; Foissner, 1984, 1987b).

Foissner (1987a) redescribed Oceanian specimen under the name of this species but we consider

that the Oceanian specimen is different species on the view of following characteristics. The number of dorsal kinety (DK) in European and Korean populations of this species is four while that of Oceanian's three. The number of DK is very stable and constant character. The average Ma number of European and Korean is 26.00 and 25.07 respectively, while that of Oceanian's 12.5. The number of Ma is slightly variable but the percentage of variation is relatively low.

As a part of the biometrical data (Table 1), the coefficients of variation (CV) were calculated. The following characters showed the CV of 0.00: number of DK, BC, FC and poVC. Thus these characters are found to be very constant and considered as the important diagnostic features of this genus or species. Comparatively low CV ranging from 5.01 to 11.88 were shown in the following characters: the numbers of RMC, LMC and Ma, and the ratio of UM/AZM and body/AZM length. These characters are relatively important for identification of the species because of their low variability. Other characters showed fairly high value of CV ranging from 12.00 to 27.37.

Family Oxytrichidae Fauré-Fremiet, 1961 尖毛下毛科

Genus *Gonostomum* Sterki, 1878 角口下毛蟲屬

2. *Gonostomum affine* (Stein, 1859) 近接角口下毛蟲

Material examined. 8 specimens, Chisan-myŏn, Sop'o-ri; 10 specimens, Imho-myŏn, Yŏndong-ri, P'aengmok; 5 specimens, Kogun-myŏn, Kŭmgŭe-ri, Hoedong.

Habitat. This species usually lives in cultivated-field and low mountain soils.

Distribution. Germany, Austria, Hungary, England, United States, Africa, Japan and Korea.

Genus *Histiculus* Corliss, 1960 組織下毛蟲屬

3. *Histiculus muscorum* Kahl, 1932 蘚苔組織下毛蟲

Material examined. 10 specimens, Ŭishin-myŏn, Sach'ŏn-ri, Ssanggyesa temple.

Habitat. This species lives in mosses or moss-covered soils.

Distribution. Germany, Austria, Africa and Korea.

4. *Histiculus cavicola* (Kahl, 1935) 四核組織下毛蟲

Material examined. 7 specimens, Ŭishin-myŏn, Sach'ŏn-ri, Ssanggyesa temple; 5 specimens, Ŭishin-myŏn, Sach'ŏn-ri, Unrimsanbang.

Habitat. This species lives in mosses or moss-covered soils.

Distribution. Germany, Austria and Korea.

Genus *Steinia* Ehrenberg, 1830 寬口下毛蟲屬(新稱)

5. *Steinia quadrinucleata* Dragesco and Njiné, 1971 네핵관구하모충(신칭) (Fig. 2)

Oxytricha candens: Hemberger, 1981, p. 139, fig. 21.

Steinia quadrinucleata Dragesco and Njiné, 1971, p. 129, fig. 26; Foissner, 1984, p. 118, fig. 62, table 29; Dragesco and Dragesco-Kernéis, 1986, p. 482, fig. 143A.

Material examined. 18 specimens, Ŭishin-myŏn, Sach'ŏn-ri, Ssanggyesa temple. Of these, seven protargol impregnated specimens were analyzed biometrically and their data were summarized in Table 1.

Description. General morphology and behavior: Body soft and flexible, oval or ellipsoidal in shape,

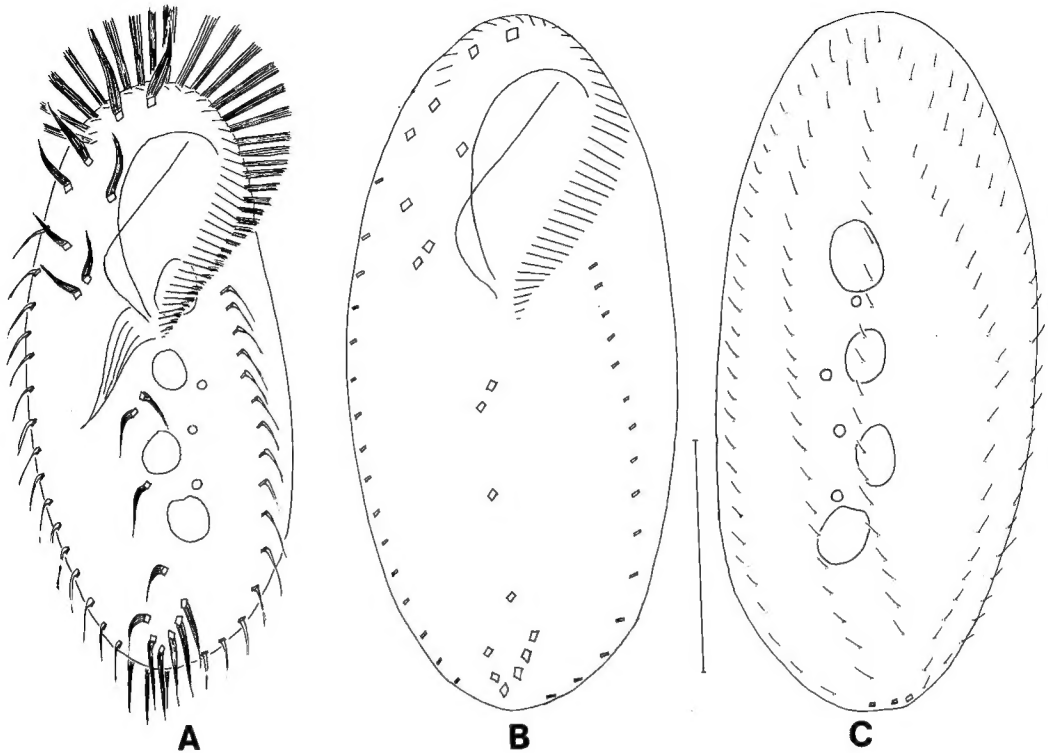


Fig. 2. *Steinia quadrinucleata* Dragesco and Njiné, 1971: **A**, live specimen, ventral view. **B**, infraciliature after protargol impregnation, ventral view. **C**, dorsal kineties and nuclear state, dorsal view. **D**, silver line system, dorsal view (Scale bar = 60 μ m).

flattened dorso-ventrally, ranging from 159-203 μ m long and 65-102 μ m wide; anterior and posterior ends slightly narrow and broadly round; ventral surface flattened and slightly concave; dorsal surface convex. Crawling movement slow and its direction changing frequently.

Frontal and buccal fields: Three frontal cirri (FC) large and prominent, located at ventral surface of anteriormost part; four frontoventral cirri (FVC) moderately large and located at right ventral surface of undulating membrane; one buccal cirrus (BC) located at middle point of paroral membrane. Adoral zone of membranelles (AZM) of 68-87 μ m long with 32-42 prominent adoral membranelles (AM), covering approximately 42% of body length. Buccal field large and deep, comprising of undulating membrane (UM) 52-71 μ m long; UM comprising of paroral membrane (PM) and endoral membrane (EM); PM curved at mid to anterior point of it and EM at posterior point respectively. Pharyngeal fibers (PF) at base of buccal field slanted to right posterior of body and 24-53 μ m long.

Somatic infraciliature: Right and left rows of marginal cirri (RMC & LMC) extending almost to posterior end; both rows of marginal cirri not confluent posteriorly; RMC beginning near anterior most FVC and bearing 16-19 cirri; LMC beginning at region beneath 9th-12th AM and bearing 15-18 cirri. Three cirri of postoral region (poVC) located beneath base of buccal field; two ventral cirri near transverse cirri (VCnTC) located near transverse cirri (TC). Posterior region of ventral surface bearing oblique or J-shaped row of five TC; each TC prominent and extending to posterior end of body. Three caudal cirri (CC) located on dorsal surface of posterior end between RMC and LMC.

Dorsal surface bearing six dorsal kineties (DK); cilia of DK bristle-like, approximately 5 μm long, some of them more or less shortened.

Nuclear organelles with 3-4 oval or elliptic macronuclei (Ma), 11-17 μm long and 10-16 μm wide, lying along median line of body. 3-6 micronuclei (Mi) spherical, 3-4 μm in diameter. Contractile vacuole spherical, positioning near left margin of body center.

Habitat. Mosses on surface of rocks or gravels.

Distribution. Cameroon, Germany, Austria and Korea.

Remarks. This species has been known in Africa and Europe. The morphological characters of this species in Europe local population are mostly similar to but slightly different from Korean population. Especially, body size, length of AZM and number of both marginal cirri are different between the two populations. The body size of Korean population is especially larger than those of previous populations. The Korean population has the average AZM length of 76.14 μm (40.70 μm in Austrian's), average AM number of 38.00 (40.00 in Austrian's), average RMC number of 16.86 (20.30 in Austrian's), average LMC number of 16.29 (18.30 in Austrian's) (Kahl, 1932; Dragesco and Njiné, 1971; Foissner, 1984; Dragesco and Dragesco-Kernéis, 1986).

This species is very similar to *Steinia muscorum* Kahl, 1932 with respect to the shape of body and adoral zone of membranelles, and pattern of ventral cirri. The present species can be distinguished from *S. muscorum* by the following diagnostic characteristics. (1) This species has four macronuclei, while *S. muscorum* has two. (2) The marginal cirri number of this species is less than that of *S. muscorum* (about 17 and 27 respectively). (3) The ratio of AZM/body length of this species is larger than that of *S. muscorum* (42-46% and 34% respectively) (Kahl, 1932; Foissner, 1982, 1984).

As a part of the biometrical data (Table 1), the coefficients of variation (CV) were calculated. The following characters showed the CV of 0.00: the numbers of Ma, DK, BC, FC, FVC, poVC, VCnTC, TC and CC. Thus these characters are found to be very constant and considered as the important diagnostic features of this genus or species. Comparatively low CV ranging from 2.30 to 10.65 were shown in the following characters: the numbers of AM, Ma, RMC and LMC, and diameter of Mi, and length of body, UM and AZM, and the ratio of UM/AZM, body/AZM length and length/width of body. These characters are very important for identification of the species because of their low variability. Other characters showed fairly high value of CV ranging from 15.43 to 30.50.

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진도의 육상 하모섬모충류

신 만 균 · 김 원*

(울산대학교 자연과학대학 생물학과. *서울대학교 자연과학대학 분자생물학과)

적 요

진도의 육상에 서식하는 하모섬모충류 5종 *Strongylidium muscorum*, *Gonostomum affine*, *Histiculus cavicola*, *H. muscorum*, *Steinia quadrinucleata*의 분류목록을 작성하였다. 이 가운데 *Strongylidium muscorum* Kahl, 1932와 *Steinia quadrinucleata* Dragesco and Njiné, 1971의 2종은 한국에서 처음으로 발견된 종으로서 이들에 대해서 재기재하였다.